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STRATEGIES FOR RESEARCH AND DEVELOPMENT PROGRAMMES IN AGRICULTURE

C V Smith

1. INTRODUCTION

The purpose of this note is not to pre-empt the views of others in ~~their~~ this currently fashionable field but:

i. to examine the general steps to be taken in any research and development programme

ii. to be fairly specific about procedures in agriculture

iii. to suggest a strategy most likely to identify key areas for the work of the agricultural meteorologist and the environmental physicist.

2. STEPS IN THE ADVANCEMENT OF A RESEARCH AND DEVELOPMENT PROGRAMME

It is suggested that something akin to the following sequence of events is needed:

i. To establish aims

As well as providing guidance on what is seen as the extent of an organisation's operations, and the directions in which its efforts are to be channelled, a statement of aims should also provide some general criteria for the inclusion or rejection of problems and problem areas in a programme of work. Such a statement should for example, indicate the relative emphasis to be given to the scientific, developmental and economic aspects of a problem.

ii. To establish general criteria for placing problems, once identified, in ranking order

The need is for procedures to establish priorities

iii. To set down the alternative strategies that will be employed to examine the options that are now open to the organisation.

iv. To identify options for research and development work.

v. To determine objectives in key areas of work.

vi. To summarise and select from the alternative and parallel strategies to be used to approach objectives.

vii. To allocate resources to objectives

viii. To monitor and control the progress of R and D programmes

In the farm situation we have the additional steps

ix. To communicate the conclusions of R and D studies to the practising farmer.

x. To monitor uptake of R and D studies on the farm

If there are any general conclusions to be drawn at this juncture, one could suggest that the piecemeal approach of individual workers left to pursue their own interests and their own ends may not be particularly efficient or even acceptable in certain circumstances. Individual flair and individual idiosyncracies cannot be constrained, but in some areas there should be benefits from a multi-disciplinary team apprcach, in which each research worker is aware of how a solution to his immediate problem connects with the work of others and contributes to an overall strategy for advancement.

3. A MORE DETAILED ANALYSIS

i. To establish aims

We are concerned here with agricultural research in general. The following is put forward as convenient statement of aims.

a. To develop a community of farmers, advisers and scientists orientated towards innovation. (All these people need, on the one hand, an awareness of the practical problems, and on the other, an awareness of the practical implications of new knowledge).

b. To meet and anticipate the needs of farmers for the technological advice necessary for economic decision-making, both in the short and longer term.

c. To maintain an expanding scientific base for such technological advice.

The emphasis here is on communication and on a balance between long and short term problems and between basic research and development.

ii. To establish general criteria for placing problems in ranking order

Suggested criteria are:

a. The likelihood of success

b. The cost of doing nothing

c. The time required to achieve success) Resource inputs

d. The cost in terms of men and money)

e. The long term advantage of a successful result) Benefits

f. The market value of a successful result)

iii. Alternative strategies to be employed to arrive at options for future work

We are concerned here to identify procedures that will arrive at innovative ideas, future needs, and areas where opportunities exist.

The following are not necessarily placed in order of preference, but the last is suggested as likely to be the most productive; certainly it offers the possibility of detailed programmes of work, and also work with which the environmental physicist would choose to be associated.

a. Serendipity

b. Brainstorming

More formal and orderly approaches are provided by:

c. Consultative committees

d. The systematic exploration of the present state of knowledge for innovative ideas, bearing in mind current trends, likely developments and discontinuities, the present subjects of research in agriculture and other loosely allied disciplines, and the type of problems that reach the extension service.

It is probably too much to expect that development in one field will parallel the requirement in another, but we could use the analysis to identify the changes in the one that call for complementary changes in the other.

e. To set down in a systematic way, and inquire into, the factors and mechanisms which affect the efficiency with which resource and energy inputs into agricultural production systems are used. The term production is taken to include storage, distribution and processing.

iv. To identify options for research and development work

If we follow up the last alternative of the previous section, we are led for example to

a. Consider those disease, weed and environmental constraints generally that prevent plants and animals, machines and farm structure from reaching their potential output.

b. Examine the mechanisms of response to inputs, with a view to increasing their efficiency.

The problems range here from the efficiency of the fundamental processes of photosynthesis (and the partition of photosynthates), of the biochemistry of the digestive systems of animals (and the deposition of digested nutrients), to more mundane questions such as the rate of field working of machines.

c. Examine the nutrient and environmental requirements of particular phases of production of plants and animals

d. Consider the restrictions on efficiency when the requirements of each phase are combined into systems of production, both for individual commodities and whole farm enterprises.

e. Examine the factors which affect the economic viability of specific systems.

We become concerned here with implied husbandry practices and the cost of implementing change, in addition to the normal considerations of fixed and variable costs.

f. Use the quantitative physical relationships required for optimisation (OR) techniques in economic decision-making to further identify gaps in our knowledge and basic understanding.

Whilst correlations may serve as well as complete theory to provide the requisite information on physical outcomes under particular sets of conditions or environmental circumstances, which is considered acceptable must be referred back to ones aims and problem priorities.

v. To determine objectives in key areas of work

Our statement of aims is limited in the sense that we are concerned with the benefits (resource savings) to the grower (and food processor) and that we place the grower as the primary beneficiary of our work.

Certain broader policy decisions may require that consideration be given to the end user of farm products and that part of our effort be devoted to his interests in the form of better quality and reduced costs. Equally, society at large may place wider horizons still, and require that attention be given to preservation and improvement of the 'environment', or to commodities whose increased production efficiency may lead to an improvement in the balance of payments or to import avoidance.

Obviously, where possible, some quantitative measure of acceptable increases in production efficiency must be employed, if only to ensure that once programmes of work have achieved certain levels of improvement, they should not continue indefinitely without review.

vi. To summarise and select from alternative and parallel strategies to be used to approach objectives

If as a specific example, we are concerned to improve plant production by a closer match of plant requirements and plant environment, we may either modify the plant or modify the environment.

On the one hand, if we propose to modify the plant we are led into such areas as

a. Plant breeding - to increase photosynthetic efficiency by modifying plant geometry

- to change disease resistance

b. Biochemistry - to develop chemical sprays which may go some way to counteract environmental hazards, eg frosts, or which offer some control over initiation or the rate of transition from one stage of growth to the next, or which again may change crop leaf geometry.

c. Husbandry practice - to change crop geometry

On the other hand, if we propose to modify the environment, we are led into such areas as:

a. Controlled environments - through enclosed structures

- through irrigation

- through soil/plant nutrients programmes

b. Biochemistry and biology – through chemical sprays against pest and disease

– through biological control of pests

c. Husbandry practice – through rotations and siting to reduce the degree of exposure to environmental hazards

These are all equally valid approaches to the same end. The time scales and expertise involved in each solution are quite different and there is no reason at this point why several lines of attack should not be developed simultaneously.

vii. To allocate resources to objectives

There must obviously be some feedback between this step and those above at 3v. and 3vi. in that the problems tackled must inevitably be constrained by the resources and expertise available.

The inbuilt advantage of the systematic procedure so far outlined is that management is forced to communicate its aims, its policy, its strategies, and that workers set out with clear cut set of initial assumptions and end points in view. Such statements should obviously be set down in black and white for future reference.

They should include such elements as

An explanatory title

An objective

A technical specification indicating the line of approach

Some reference to timing and time limits

Estimates of cost

Criteria for success

viii. To monitor and control the progress of R and D programmes

Such a procedure implies that we have

A plan or target

A system for monitoring progress

The comparison of progress with that planned

A mechanism for adjustment of the plan

Operational Research techniques have an application here, for example, when the work of individuals or groups has to be co-ordinated to meet a final deadline, or when the start of one activity or phase of work is all dependent upon the completion of other sections of the programme. Critical Path Analyses (CPA) and Programme and Review Techniques (PERT) spring to mind here. Even simple flow diagrams of activities could prove helpful, not least because one can include a termination point.

ix. To communicate the conclusions of R and D studies to practicising farmers

This has been an essential activity of the agricultural extension service for many years and calls for little comment here. Obviously if there is a forum where farmers, advisers and research development workers can meet to exchange ideas, and if farmers are involved in the decision-making process, then the communication problem is that much simpler.

x. To monitor uptake of R and D studies on the farm

The introduction of innovative ideas has to be timely in the sense that

- farmers have to be receptive to the ideas
- farmers should be able to profit from them
- farmers should possess the management skills to introduce the new practices.
- farmers should possess the physical resources to introduce the new practices.

4. THE WORK OF THE AGRICULTURAL METEOROLOGIST

The deliberate intention in this note has been to paint a broad canvas for agricultural research and development generally, to concentrate on strategies and their logical evolution and consequences.

The work of the agricultural meteorologist has to lie within this framework. Aims, with different detailed emphasis to those suggested above can be permitted to the agricultural meteorologists; but these must be comparable with, and fall within the set comprised, by the broader, agricultural research aims. The emphasis has to be on agriculture; though some feedback in terms of ideas, analogies and analyses to meteorology as a science based business would seem desirable. This however is a separate question and a separate study; its acceptance requires policy decisions above my level.

The intention here has been simply to present a scheme which offers the agricultural meteorologist a co-ordinated structure which he can begin to clad and furnish with his own peculiar expertise, and with his understanding of the physical processes in environment and the response of materials and living organisms to changes in the environment.

Meteorological Office
Cambridge

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